Handling

The following handling techniques can assure the safety and protection of personnel from injury and the integrity of waste containers:

1. Untreated medical wastes should only be compacted if the compaction takes place in a closed chamber which eliminates the possibility of exposure to infectious agents through aerosols.

2. Medical wastes should not be transferred through chutes or dumb waiters. Collection by gravity or pneumatic chute can also result in the forcing of contaminated air down the shaft and horizontally into other outlets located elsewhere in the building (e.g., nursing stations and other clinical areas).

3. Carts used to transfer wastes within the facility should be frequently disinfected. They should not be used for other materials (e.g., food service, patient baggage transfer) prior to decontamination.

Containment

The structures that are used for the containment of medical wastes during storage, transport, treatment and disposal can reduce the probability of the transmission of infection. In addition, proper containment of medical waste protects workers from physical injury, reduces the possibility of unaesthetic appearances, and greatly expedites the waste handling process.

1. Clearly marked, easily accessible containers for each type of waste will encourage optimal segregation.

2. The containers should be located in the immediate area of use.

3. These containers can include recyclables and reusables within the scope of hospital infection control policy and liability concerns, as well as medical and solid waste categories.

4. Too many containers can confuse and discourage health care personnel from attempting to properly designate the various wastes. Too few containers result in all wastes being designated for the costly and more involved process necessary for only certain types of waste.

5. Replace the containers routinely and don't allow them to become overfilled.

6. Seal all bags by lapping the gathered open end and binding with tape or closing device such that no liquid can leak.

7. If the outside of the bag is contaminated with body fluids, use a second outer bag. Use of double plastic bags for liquid waste is recommended.

8. If containers are to be reused for medical waste storage, handling or transport, thoroughly wash and decontaminate them by an approved method each time they are emptied, unless the surfaces of the containers had been protected by disposable liners, plastic bags or other means which are removed and disposed of with the waste. Include agitation (scrubbing) in the cleaning process to remove any visible solid residue, followed by disinfection.

9. Enclose and store incinerator ash in tightly lidded containers or sturdy plastic bags or contain it in such a way that waste transport workers will not be exposed to inhalable dust or spill when transferring the ash.

10. Select packaging materials that are appropriate for the type of waste and treatment process. Use packaging that maintains its integrity during storage and transport.

11. Don't use glass containers as primary containers for transportation of medical waste. Place glass containers into a rigid or semi-rigid, leakproof container and protect from breakage.

12. Use plastic bags that are impervious to moisture, puncture resistant, and distinctive in color or markings.

13. Reusable containers should be constructed of either heavy wall plastic or noncorrosive metal. Don't use these containers for any other purpose, unless they have been properly disinfected and have had medical waste symbols and labels removed.

14. Support heavy materials in double-walled corrugated fiberboard boxes or equivalent rigid containers.

15. Place liquid pourable wastes in leak-proof, rigid, puncture resistant, break resistant containers, capped or tightly stoppered bottles or flasks.

16. Place needles, syringes, breakable items and other sharps in a plastic vial or puncture-resistant box before they are placed into the bag. Needles should not be clipped or recapped by hand. Syringes should not be crushed.

17. OSHA Instructions specify the following recommendations for antineoplastic drug wastes (OSHA Instruction PUB 8-1.1, Office of Occupational Medicine, p. A-14, A-15):

a. Place antineoplastic drug wastes in sealable plastic or wire-tie bags of 4-mil-thick polyethylene or 2-mil-thick polypropylene, labeled with a cytotoxic hazard label and colored differently from other hospital trash bags. Use these bags for the routine accumulation and collection of used containers, syringes, discarded gloves, gowns, goggles, and any other disposable material.

b. Place needles, syringes and breakable items in a plastic vial or puncture proof box before they are placed into the bag. Don't clip or cap needles or crush syringes.

c. Keep the bag inside a covered waste container clearly labeled "cytotoxic waste only."

d. Locate at least one such receptacle in every area where the drugs are prepared or administered so that the waste need not be moved from one area to another. Seal the bag when it is filled and tape the carton.

Labeling

Each container to be transported off-site should be clearly marked as medical waste immediately after packaging. The label or tag should also identify the generator, transporter and date of shipment.

1. Label medical waste to be transported off-site immediately after packaging. The label should be securely attached to the outermost container and be clearly legible. The label may be a tag securely affixed to the package by string, wire, adhesive or other method that prevents loss or unintentional removal.

2. Use indelible ink to complete the information on the label. The label should be at least three inches by five inches in size. The lettering for "medical waste" should be no less than one inch in height. The wording should be readily visible from any lateral direction when the container is upright.

3. Include the following information:

a. The name, address, business telephone and state permit or identification number (if applicable) of the generator;

b. "Biomedical Waste" or "Medical Waste" in large print;

c. The name, address, business telephone and state permit or identification number (if applicable) of all transporters, treatment facilities, or other persons to whose control the medical waste is transferred. License number of transporters shall be provided if applicable;

d. The international biohazard symbol;

e. The date upon which the medical waste was packaged.

4. Label treated medical waste with the following information:

a. The name, address and business telephone number of the generator;

b. The date upon which the medical waste was treated;

c. Treatment method utilized;

d. Statement indicating that the waste has been treated and is no longer medical waste.

Storage (Prior to treatment)

Medical wastes may need to be stored on-site until a large enough quantity is accumulated to warrant treatment at the facility or until collection for transport to an off-site treatment facility is scheduled. Treatment system malfunction or staff shortages may also necessitate storage of waste. In addition, intermediate storage facilities may be necessary enroute to off-site facilities. Rural areas may find that the use of transfer or collection stations expedites proper management by small generators. All storage areas or units should be well secured to discourage access of drug users to needles and animals to organic matter (i.e., body parts) contained in the waste.

The following conditions apply to storage, transfer and collection stations:

1. Store medical waste in a specifically designated area located at or near the treatment site, or at the pickup point if it must be transported off site for treatment.

2. All areas used to store medical waste should be durable, easily cleanable, impermeable to liquids, and protected from vermin and other vectors.

3. Keep all storage areas clean and in good repair.

4. The manner of storage should maintain the integrity of the containers, prevent the leakage of waste from the container, provide protection from water, rain, and wind, and maintain the waste in a nonputrescent, odorless state.

5. Don't use carpets and floor coverings with seams in storage areas. The floor should be impervious to liquids with a perimeter curve. The floor should be sloped to drains connected to an approved sanitary disposal system.

6. Provide the room with exhaust ventilation.

7. For security reasons, limit access to the area to those persons specifically designated to manage medical waste.

8. Post such areas prominently with the universal biohazard symbol and with warning signs located adjacent to the exterior of entry doors, gates, or lids indicating use of the area for storage of medical waste and denying entry to unauthorized persons.

9. Treatment facilities should not store more than seven times the facility's total throughput capacity.

10. Maintain storage areas, including vehicles, at a temperature so as to control odors and to prevent conditions that will lead to putrefaction.

11. Duration:

a. Storage time should be minimized;

b. Time in transit shall be considered as time in storage;

c. Storage requirements begin once the container is no longer being filled.

12. OSHA specifies that antineoplastic wastes that are to be picked up by a commercial disposal firm must be held in a secure area in covered, labeled drums lined with 6.5-mil polyethelene liners.

13. Collection or transfer stations should submit the following information to the state division of solid waste management:

a. the name and address of the facility;

b. the name of the individual responsible for the operation of the facility;

c. the license number of the facility;

d. the area to be served by the facility.

Monitoring and Record Keeping

In *Illinois* generators of medical waste who treat such waste must keep and make available records: (1) of any required spore assay tests; (2) describing the approximate amount of waste treated; and (3) which demonstrate proper operation of treatment equipment. These requirements may be met through compliance with hospital licensing record keeping requirements, as long as the information is adequate to satisfy the three requirements above (McDowell, 1990, p.34).

Training

Although the intent of this document is for the management of medical waste, the safety and health of those who handle these wastes is certainly a related issue. Waste handlers are not as susceptible to injury or disease from medical wastes as are healthcare workers who routinely handle medical materials before and during medical procedures as well as after it enters the wastestream. But, the same safety precautions that are prescribed for medical personnel can be applied to anyone who handles medical wastes.

Of particular interest are the standards currently under development by OSHA to protect workers from occupational exposure to blood-borne diseases. Until the final regulations are in place, the requirements of OSHA Instruction CPL 2-2.44B on the inspection of healthcare facilities entitled Enforcement Procedures for Occupational Exposure to Hepatitis B Virus (HBV) and Human Immunodeficiency Virus (HIV) provide safeguards for healthcare workers who may be occupationally exposed to blood-borne pathogens. Occupational exposure is defined as "reasonably anticipated skin, eye, mucous membrane, or parenteral contact with blood or other potentially infectious materials that may result from the performance of an employee's duties" (American Dental Association, 1990, Infection Control-p. 9).

The instructions recommend training "high risk workers" (those who are at routinely increased exposure to body fluids from potentially infected patients) in the use of universal precautions. Universal precautions refers to a system of infectious disease control which assumes that every direct contact with body fluids is infectious and

Monitoring and Record Keeping

Generators of medical waste that is to be transported to a treatment facility should maintain records of the types of wastes being transported, the method of treatment, the designated treatment facility, and the transporter. Such records provide liability protection to the generator as well as documentation of good waste management practice.

Generators who treat waste on-site should keep available records on file at the generator location: (1) of spore assay tests; (2) describing the approximate amount of waste treated; and (3) which demonstrate proper operation of treatment equipment.

Compliance with OSHA Instruction CPL 2-2.44B and other OSHA regulations may require records for each employee that contain the circumstances of any exposure incident, including date, location, nature of the incident and the name of the person who is the source of the medical waste. These medical records must be kept confidential except for disclosure or reporting required by OSHA or by law.

Training

Training of personnel who handle medical waste at the site of generation will help to ensure immediate and accurate identification and segregation of wastes and safe and effective handling procedures.

Training should include the following components:

1. Explanation of waste management plan.
2. Assignment of roles and responsibilities for implementation of the plan.
3. The epidemiology, modes of transmission and prevention of HIV and HBV.
4. Possible risks to the fetus from HIV, HBV and other infectious agents.
5. The location and proper use of personal protective equipment.
6. Proper work practices and "universal precautions."
7. The meaning of color codes, the biohazard symbol and precautions to follow in handling contaminated articles or medical waste.
8. Procedures to follow if a needlestick or other exposure incident occurs.
9. Waste minimization procedures.
10. Training should be implemented when management plans are first developed and instituted, when new employees are hired, and whenever management practices are changed.

Contingency Planning

Medical waste generators should be prepared for unexpected situations such as accidental spills, loss of containment, exposure, equipment failure, and interruptions or delays in waste collection services that may require the use of alternative facilities. Procedures for handling these incidents should be formulated and disseminated to waste handlers.

Equipment and procedure for response to large spills of medical waste should include the following items. Small generators may handle only specific types and volumes of medical waste. They may select equipment that is adequate to handle these waste types and amounts.

1. Management of spills of medical waste.

All medical waste management facilities should keep a spill containment and cleanup kit within the vicinity of any area where medical wastes are managed, and the location of the kit shall provide for rapid and efficient cleanup of spills anywhere within the area. The kit should consist of at least the following items:

a. material designed to absorb spilled liquids. The amount of absorbent material should be that having a rated capacity of one gallon of liquid for every cubic foot of medical waste that is normally managed in the area for which the kit is provided or ten gallons, whichever is less. For vehicles transporting medical waste, the amount of absorbent material should be rated to absorb ten gallons.

b. one gallon of hospital grade disinfectant in a sprayer capable of dispersing its charge in a mist and in a stream at a distance sufficient to prevent contact of the worker with the spill or splashing from the sprayer. The disinfectant should be hospital

requires every employee exposed to direct contact with body fluids to be protected as though such body fluids were HBV or HIV infected. The precautions are intended to prevent health care workers from parenteral, mucous membrane, and nonintact skin exposures to blood-borne pathogens (U.S. Department of Labor, 1990, p.4).

Of particular importance to waste handlers, OSHA requires the implementation of specified housekeeping, waste handling and labeling procedures and provision of training programs for employees and maintenance of certain records.

As of 1990, 23 states and two territories have been approved to operate their own occupational safety and health plans. These plans must enforce standards for occupational exposure to blood- borne pathogens that are "at least as effective" as the federal standard (American Dental Association, 1990, Infection Control-p. 6).

grade and effective against mycobacteria.

c. enough red plastic bags to double enclose 150% of the maximum load accumulated or transported, that meet the ASTM 125 pound drop weight test and are accompanied by sealing tape or devices and labels or tags. These bags shall be large enough to over-pack any box or other container normally used for medical waste management by that facility.

d. two new sets of liquid impermeable and disposable overalls, gloves, boots, caps and protective breathing devices. Overalls, boots and caps shall be over-sized or fitted to medical waste workers and be made of materials impermeable to liquids. Boots may be of thick rubber and gloves shall be of heavy neoprene or equivalent. Boots, gloves and breathing devices may be reused if fully disinfected between uses. Tape for sealing wrists and ankles shall also be in the kit.

e. a first aid kit and boundary marking tape.

2. Containment and cleanup procedures:

a. Leave the area until the aerosol settles (no more than a few minutes delay).

b. The cleanup crew will don the cleanup outfits described above and secure the spill area.

c. Spray the broken containers of medical waste with disinfectant.

d. Place broken containers and spillage inside over pack bags in the kit, minimizing exposure.

e. Disinfect the area and take other cleanup steps deemed appropriate.

f. Clean and disinfect cleanup outfits before removing.

g. Remove cleanup outfits and place disposable items in cleanup bag.

h. Collect and handle all spill wastes as medical waste.

i. Take necessary steps to replenish containment and cleanup kit with items used.

3. Exceptions for small spills may be allowed.

4. Alternative arrangements for waste storage and treatment should be provided for in the event of equipment failure.

5. Exposure incidents.

OSHA defines occupational exposure as reasonably anticipated skin, eye, mucous membrane or parenteral contact with blood or other potentially infectious materials that may result from the performance of an employee's duties.

OSHA Instruction 2.44B on occupational exposure to bloodborne disease recommends the following procedures to insure compliance with OSHA inspections:

a. For any persons exposed to a medical waste spill who consents and so desires: collect a blood sample as soon as possible after the exposure incident for the determination of HIV antibody status.

b. Advise the exposed individual to report and seek medical evaluation of any acute illness accompanied by a fever that occurs within 12 weeks of the exposure incident.

c. Offer retesting for HIV antibody to individuals who are seronegative at 6 weeks, 3 months, and 6 months after the exposure incident.

d. Produce a follow-up report on whether any infection due to exposure actually occurred.

III. TRANSPORTATION

Medical waste that is not treated at the site of generation must be transported to a treatment or disposal facility. The remainder of waste (i.e., treatment residues or treated waste) that has been treated on-site, such as incinerator ash or autoclaved waste, must still be hauled to a permanent disposal facility. Proper management at this stage of the treatment process will ensure accountability for proper containment and handling of the material until its final destination.

In the selection of a waste hauler, the generator may want to obtain the following information: the size of the hauler's operation, state permits or operator's licenses, how long it has been in business, truck type, security measures and worker safety precautions or the details of the waste management plan, if the company indemnifies the generator (e.g., exempts from loss or damage) for its mishandling of the waste, and if the hauler will provide documentation needed for compliance with federal, state or local regulations.

Waste Management Plan

The transporter's waste management plan should contain policies and detailed procedures for the safe and effective management of medical waste and should provide for contingencies in emergency situations. The policies and procedures portions of the plan should be available to the public. The entire plan should be available to public health and environmental officials.

A commercial transporter in charge of a business that transports medical waste should prepare a management plan for the medical waste handled by the commercial transporter. The plan should describe the following items to the extent the information is applicable to the commercial transporter:

1. The type of medical waste that the commercial transporter handles;
2. The transportation procedures for the medical waste that will be followed;
3. The disposal facilities that will be used for the medical waste;
4. The steps that will be taken to minimize the exposure of employees to infectious agents throughout the process of transporting and disposing of medical waste;
5. The name of the individuals responsible for the transportation and management of the medical waste; and
6. The name(s) and phone numbers(s) of emergency coordinators and response procedure to control emergency situations.

Operation

All medical wastes to be transported should be properly segregated and identified. Vehicles should be operated by competent drivers in such a manner so as to ensure the safe containment and transport of materials to its destination.

Vehicles and compartments used to transport medical waste should be designed to facilitate the least stress to the structural integrity of medical waste containers. They should protect waste handlers and the public from accidental exposure to medical waste materials.

Small generators may transport sharps by U.S. Registered Mail, return receipt requested, to a disposal service. Sharps that have been encapsulated in a polymer matrix can be shipped via the United Parcel Service to a manufacturer of the process in Georgia. In addition, small generators may use their own vehicles to transport waste to the disposal facility. The small generator should have a written agreement stipulating that the disposal facility will accept the medical waste.

Transporters should practice the following procedures:

1. Avoid mechanical loading devices which may rupture packaged wastes.

Guidelines

2. Prominently identify vehicles transporting untreated medical waste on the two sides and the back of the cargo compartment with the following: the universal biohazard symbol, the words "medical waste," "biomedical waste," or "biohazard."
3. Limit access to vehicles, equipment, and service or parking areas used in the transportation of medical waste to those persons specifically designated to manage medical waste.
4. Guidelines of the storage section shall be applicable during transportation.
5. Medical waste should not be transported in the same vehicle with other waste unless the medical waste is separately contained in rigid containers or kept separate by barriers from other waste, or unless all of the waste is to be treated and disposed of as medical waste. Subsequent uses of vehicles should be compatible with the vehicle's prior use as a medical waste carrier. Backhauling by refrigerated vehicles is discouraged.
6. All transport vehicles and equipment used to transport medical waste must be thoroughly cleaned and disinfected weekly, before being used for any other purpose, and prior to any transfer of ownership. OSHA recommends that transporters with vehicles that are to be used for purposes other than hauling biomedical waste develop a quality control plan using biological challenges to evaluate the effectiveness of cleaning/disinfecting.
7. Recycled containers which are used repeatedly for transport and treatment of bagged waste should be disinfected after each use.
8. All vehicles transporting medical wastes should carry a spill containment and cleanup kit in the vehicle whenever medical wastes are conveyed. (See contingency planning for kit contents.)
9. Direct physical contact of the transport vehicle or equipment with

Monitoring and Record Keeping

West Virginia's draft proposed medical waste rules require all persons transporting medical waste to possess a valid license from the Public Service Commission. Applications for such license shall contain at a minimum the following:

1. Name of person or firm.
2. Business address and telephone number of person or firm, including headquarters and local office.
3. Make, model, and license number of each vehicle to be used to transport medical waste within the state.
4. Name, business address, and telephone number of each driver who will operate in the state.
5. Area (counties and cities) in the state in which the transporter will operate.
6. Any person or firm associated with the applicant firm or any other name under which that person or firm does business.
7. Any other person or firm using any of the same vehicles and operators.
8. The name and telephone number of a person who may be contacted in the event of an accident or release.
9. Detailed description of the methods to comply with spill management requirements.
10. Detailed description of the methods to be utilized to clean and disinfect the transport vehicles and equipment as required.
11. Verification that the applicant and all its employees involved in the transportation of medical waste are familiar with the provisions of this rule and agree to comply in full with said provisions.

The *Pennsylvania Interim Guidelines: Manifesting and Transporter Licensing for Infectious and Chemotherapeutic Waste* require that:

1. A transporter should not accept medical waste unless it is accompanied by a manifest which has been properly completed and signed by the generator.
2. A transporter should deliver the entire quantity of waste to the facility designated on the manifest or the next designated transporter listed on the manifest.
3. No owner or operator of a processing or disposal facility should accept medical or chemotherapeutic waste shipments received from off-site sources unless the shipment is accompanied by a manifest.
4. If there is a significant discrepancy in a manifest, the owner or operator should attempt to reconcile the discrepancy before the waste covered by the manifest is processed or disposed at the facility.

A discrepancy is a difference between the quantity or type of waste designated on the manifest, and the quantity or type of waste a facility actually receives.

A significant discrepancy occurs if any of the following apply:

a. Variations greater than 5% in weight.

b. Variations in piece count, such as number of boxes or bags, for batch waste.

c. Differences in waste type which can be discovered by inspection.

medical waste should be considered and managed as a spill.

Monitoring and Record Keeping

Monitoring of medical waste transportation helps to assure that wastes generated are properly assigned and hauled to a treatment or disposal facility. Accurate records assist in the identification of illegal hauling and disposal methods. Record keeping provides written documentation of the source of the medical waste, its type and amount, the intended treatment method, and the parties responsible for its ultimate proper disposal.

Training

Transporters of medical waste should provide training for the operators of vehicles that will transport medical waste. The training should include:

1. Familiarity with the contingency plans;
2. Instruction in personnel protection and safety that is appropriate to the risk that may be encountered in the transportation and handling of medical waste;
3. How to recognize waste that is unacceptable or that is packaged in such a fashion that it is not acceptable to the processing/disposal facility;
4. How to recognize a complete and correct bill of lading; and
5. How to use the recordkeeping system that is used by the owner/operator of the hauling company.

Contingency Planning

Contingency planning for medical waste transporters is the development of a plan of action in the event of an accidental spill, loss of containment, equipment failure or other unexpected circumstance.

Owners/operators of vehicles used in the transportation of biomedical waste should carry contingency plans for emergencies that address the following:

1. Plans for disinfection of the truck and any contaminated surface if a leaking container is discovered.
2. A notification list of individuals/agencies who are to be contacted in the event of a transportation accident. This list will include the local police

or sheriff, local highway patrol, local county health department, and solid waste division.

3. A plan for action that will be taken following a transportation accident. This plan should address the clean-up and decontamination of potentially contaminated surfaces; designation of back-up transportation for the medical waste; a description of the plans for the re-packaging and labeling of medical waste where containers are no longer intact.

4. Procedures that will be followed if a fire, theft or natural disaster occurs.

5. Procedures for the management of a leaking container or a container that has lost its integrity and procedures for the correct management of a container or truckload of waste that is not accepted by the processing/disposal facility, for whatever reason.

IV. TREATMENT, DESTRUCTION & DISPOSAL

The U.S. General Accounting Office reports that hospitals treat about 85 percent of their wastes on-site. The U.S. EPA estimates that approximately 70 percent of hospital medical waste is incinerated on-site and about 15 percent is steam-sterilized on-site in an autoclave. The other 15 percent is generally shipped off-site for autoclaving or incineration (U.S. General Accounting Office, 1990, p. 9).

There is not a uniform technical definition of effective treatment and the type or degree of treatment that is considered sufficient to render a waste incapable of transmitting infection.

Documentation

Three treatment methods for medical waste are sterilization, disinfection and decontamination/sanitization.

1. *Sterilization* is the destruction of all forms of microbial life, including viruses and fungal or bacterial endospores on inanimate surfaces;

2. *Disinfection* is the reduction of microbial life to levels at which infection is not likely, e.g., is free of bacterial or fungal endospores; and

3. *Decontamination/sanitization* is the reduction of microbial content on an inanimate surface to such an extent that an item is safe to handle (U.S. Department of Health and Human Ser-

Guidelines

Treatment is any method, technique or process designed to change the biological character or composition of waste to reduce or eliminate pathogens so that the waste no longer poses a hazard to persons who may be exposed to it. Sterilization may not be necessary in every situation. It is the removal or deactivation of pathogens that is important.

Cultures and stocks are the medical wastes of greatest concern. These wastes are the result of microorganisms or specimen cultures produced in laboratories in which etiologic agents (human infectious disease

Comparison of Treatment Technologies

	Type of Treatment Technology		
Factor	*Steam Sterilization*	*Incineration*	*Hammermill/Chemical Treatment*
Operations			
Applicability	Most infectious wastes	Almost all infectious wastes	Most infectious wastes
Equipment operation	Easy	Complex	Moderately complex
Operator requirements	Trained	Highly skilled	Well trained
Need for waste separation	To eliminate non-treatable wastes	None	To eliminate non-treatables; for proper feeding
Need for load standardization	Yes	No	When feeding by type of waste
Effect of treatment	Appearance of waste unchanged	Waste burned	Waste shredded and ground
Volume reduction	30%	85-95%	Up to 85%
Occupational hazards	Low	Moderate	Moderate
Testing	Easy, inexpensive	Complex, expensive	Protocol under development
Potential side benefits	None	Energy recovery	Use of effluent in laundry
Onsite/off-site location	Both	Both	Both
Regulatory Requirements			
Medical waste tracking regulations	Applicable	Record-keeping	Not applicable
Applicable environmental regulations	Wastewater	Air emissions, ash disposal, wastewater	Wastewater
Releases to air	Low risk via vent	High risk via emissions	Low risk via vent
Releases to water	Low risk via drain	Low risk via scrubber water	Moderate risk via wastewater
Disposal of residue	To sanitary landfill; potential problem with red bags	Ash may be a hazardous waste; if so, to RCRA-permitted landfill	Effluent to sanitary sewer; residue to sanitary landfill
Permitting requirements	None	For siting, air emissions	None
Costs			
Capital	Low	High	Moderate
Labor	Low	High	Moderate
Operating	Low	High	Moderate
Maintenance	Low	High	Moderate
Downtime	Low	High	Moderate to high

(*Source:* Reinhardt and Gordon, 1991, pp. 67-68)

vices, 1990, p. 7.1).

Wastes that, although not potentially infectious or rendered non-infectious by treatment may still be aesthetically offensive or frightening. They therefore may require further treatment (e.g., grinding) to render them unrecognizable. These wastes do not represent a public health hazard, but for states in which one of the goals of medical waste management is to address the public's fear of these wastes, alteration of its physical appearance may be warranted.

Waste Suitability

Not only the category of medical waste but its physical composition and packaging influences the selection of the optimal treatment, destruction and disposal method. For example, higher levels of polyvinyl chloride (PVC) plastics in medical wastes may be contributing to higher concentrations of hydrogen chloride (HCl) in emissions, on average, from medical waste incinerators compared with municipal solid waste incinerators (U.S. Congress Office of Technology Assessment, 1990, p. 21).

Cultures and stocks — biosafety level four laboratory standards

"Liquid effluents from laboratory sinks, biological safety cabinets, floors, and autoclave chambers are decontaminated by heat treatment before being released from the maximum containment facility. Liquid wastes from shower rooms and toilets may be decontaminated with chemical disinfectants or by heat in the liquid waste decontamination system. The procedure used for heat decontamination of liquid wastes is evaluated mechanically and biologically by using a recording thermometer and an indicator microorganism with a defined heat susceptibility pattern. If liquid wastes from the shower rooms are decontaminated with chemical disinfectants, the chemical used is of demonstrated efficacy against the target or indicator microorganisms . . .

"The exhaust air from the facility is filtered through HEPA (high efficiency particulate air) filters and discharged to the outside so that it is dispensed away from occupied buildings and air intakes. Within the facility, the filters are located as near the laboratories as practicable in order to reduce the

causing agents) must be grown in high concentrations. These wastes should be sterilized or incinerated. Some treated medical wastes, although non-infectious, may still be aesthetically offensive. For this reason, treatment may include processes, such as grinding, that cause waste to become less recognizable. This additional treatment step considerably increases the cost and complexity of the waste handling process, but states may find it worthwhile if it helps to alleviate the public's fear of medical wastes.

Treatment does not always precede disposal, as is the case of the discharge of liquid wastes by a generator to a sewer for treatment at a sanitary sewage facility. Incinerator emissions are also a form of disposal (to the air) that occurs simultaneously with the treatment and destruction of waste.

Waste Suitability

The ten categories of medical wastes and the treatment, destruction, and disposal methods that are suitable for each are listed below, given they comply with all applicable regulations.

1. *Sharps*

Sharps are the waste category of greatest concern because of their ability to puncture the skin, thereby creating a portal of entry for the transmission of disease. The treatment goal should therefore be to prevent human exposure and injury. Sharps are generated by both commercial facilities such as hospitals and dentist offices and by households such as self-care by diabetics and outpatients. Treatment options for the two types of generators are as follows.

a. Commercial generators:

i. placement in a puncture-resistant, leak-proof container, chemical disinfection, and disposal in a sanitary landfill;

ii. placement in a puncture-resistant container, steam sterilization, and disposal in a sanitary landfill;

iii. placement in a puncture-resistant, leak-proof container, incineration, and disposal in a sanitary landfill; or

iv. encapsulation in a matrix which will solidify and deposition in a landfill. The encapsulation process uses a phenolic solution to disinfect sharps and an oxidizing agent to encapsulate them in a polymer matrix that is a solid block-like material.

b. Household generators:

Package sharps waste in such a manner that it will greatly reduce the likelihood that anyone who handles the waste would be exposed to needles. This should involve placing syringes needles in a puncture resistant, tightly lidded container prior to disposal. The common two liter PET plastic soda bottle is recommended because of its ability to withstand the compactions associated with the waste stream. The container should then be sealed and appropriately labeled (e.g. "WARNING: Sharps" or "WARNING: Syringes"). Because plastic bottles are recyclable, it is also advisable to put "Do Not Recycle" on the label.

2. *Cultures and Stocks*

Cultures and stocks of microbiological agents are artificially grown in laboratories to what could be an extremely high dose for an exposed individual, much greater than would be normally found in nature. For this reason, the treatment goal for cultures and stocks should be complete destruction prior to disposal into the general waste stream. Treatment and disposal methods are as follows.

a. steam sterilization followed by disposal in a sanitary landfill;

b. incineration followed by disposal in a sanitary landfill;

c. thermal inactivation followed by disposal in sanitary landfill; or

d. chemical disinfection followed by disposal in a sanitary landfill.

3. *Bulk human blood and blood products*

Although blood-contaminated items can be visually frightening, the real risk of disease tramsmission would be no greater than that posed by commonly found items in the waste stream such as feminine hygiene products or disposable diapers (e.g., human contact must be made). But, when blood enters the waste

length of potentially contaminated air ducts. The filter chambers are designed to allow in situ decontamination before filters are removed and to facilitate certification testing after they are replaced. Coarse filters and HEPA filters are provided to treat air supplied to the facility in order to increase the lifetime of the exhaust HEPA filters and to protect the supply air system should air pressure become unbalanced in the laboratory" (U.S. Department of Health and Human Services, 1988, p. 26-27).

Radioactive, cytotoxic and chemical wastes:

The Agency for Toxic Substances and Disease Registry finds that "materials such as antineoplastic agents, toxic chemicals, radioisotopes, and chemicals volatilized by steam should not be autoclaved, to prevent possible contact during autoclave opening and venting and secondary contamination during subsequent process cycles. Chemical decontamination is usually the method of choice for these substances" (U.S. Department of Health and Human Services, 1990, p. 7.2).

The Oklahoma State Department of Health has issued the following instructions for disposal of antineoplastic agents and related wastes that are not regulated as hazardous waste at permitted biomedical waste incinerators:

"Each waste container, as packaged for transportation and incineration, may contain only one container of an antineoplastic agent that has been prepared but not administered, or one container of an antineoplastic agent that was partially administered or one container of an antineoplastic agent that has not been diluted (prepared for administration) that is being discarded because it is out-of-date or has been contaminated.

"The waste container may be filled with other infectious waste or chemical waste, including disposable materials which have come in contact with antineoplastic agents during preparation, handling and administration of such agents. Such waste includes, but it not limited to masks, gloves, gowns, empty IV tubing bags and vials, and other contaminated materials."

stream as a liquid, it has the potential to spray to the mucous membranes of anyone in the spray path when compacted in the waste stream. The following methods are recommended for bulk blood and blood products.

a. discharge to a sanitary sewer system;

b. discharge to an approved on-site septic system;

c. incineration followed by disposal of the residue in a sanitary landfill.

4. *Pathological wastes*

Although of no greater risk of disease transmission than other components of the waste stream, pathological wastes possess the potential to shock or offend aesthetically. These wastes should therefore be rendered unrecognizable before disposal by the following methods.

a. incineration followed by disposal of the residue in a sanitary landfill;

b. steam sterilization and grinding followed by disposal in a sanitary landfill; the American Dental Association recommends that, if included, extracted teeth containing metal restorations should not be autoclaved prior to disposal because of the possible release of potentially harmful vapors, such as mercury vapor.

c. thermal inactivation and grinding followed by disposal in a sanitary landfill;

d. chemical disinfection and grinding followed by disposal in a sanitary landfill.

5. *Isolation wastes*

Because of their potential to contain CDC level 4 pathogens, the treatment goal for isolation wastes is sterilization. Treatment methods are as follows.

a. incineration followed by disposal of the residue in a sanitary landfill;

b. steam sterilization followed by disposal in a sanitary landfill;

6. *Animal waste*

These are wastes that have been exposed to zoonotic disease and therefore require sterilization. Treatment and disposal methods are as follows.

a. carcasses, body parts, fluids and bedding — steam sterilization and grinding of carcasses and body parts followed by disposal in a sanitary landfill;

b. carcasses, body parts, fluids and bedding — useful to decontaminate the surface of a carcass before transporting to an incinerator; incineration followed by disposal of the residue in a sanitary landfill;

c. fluids — thermal inactivation followed by disposal in a sanitary landfill or discharging into a sanitary sewer system;

d. fluids — chemical disinfection followed by disposal in a sanitary landfill or discharging into a sanitary sewer system.

7. *Unused sharps*

a. placement in a puncture-resistant, leak-proof, hard-to-open container, chemical disinfection, and disposal in a sanitary landfill;

b. placement in a hard-to-open, puncture-resistant container, steam sterilization, and disposal in a sanitary landfill;

c. placement in a puncture-resistant, leak-proof container, incineration, and disposal in a sanitary landfill; or

d. encapsulation in a matrix which will solidify (see *Sharps:* a.iv.) and deposition in a landfill.

8. *Low-level radioactive waste (not under Nuclear Regulatory Commission regulation)*

a. chemical decontamination; should NOT be steam sterilized.

9. *Antineoplastic drugs (trace amounts not handled as RCRA hazardous wastes)*

a. chemical decontamination; should NOT be steam sterilized.

10. *Small volumes of chemical hazardous waste (exempt from Subtitle C of RCRA)*

a. chemical decontamination; should NOT be steam sterilized.

Waste Management Plan (General)

Each facility should have a written medical waste management and operations plan which includes the following:

1. A description of the biomedical waste handled by the facility including type and volume of waste;